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Art. V.—*Contributions to the Flora of Australia, No. 35.** *The Naturalized Aliens of Victoria.*

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These now form a prominent part of the Flora of Victoria, and they are steadily increasing both in numbers of species and of individuals. In 1909 the number of aliens recorded was 363, and in 1928 it had risen to 461. This rate of increase represents approximately one every two months, or slightly more than five a year, and this rate of increase has been maintained with remarkable uniformity during the past sixty years. The alien plants are also more numerous in individuals than the native flora, although the latter represents a much larger number of species, about 3000, and the aliens occupy a greater area of the soil than does the native flora outside of the forest areas.

Nevertheless, all the aliens are not obnoxious, since they include all the clovers, trefoils and medicks, most of the more valuable pasture grasses, and some garden plants that have run wild. Less than a hundred of the aliens are serious weeds, and few of them represent as serious a menace as does our native bracken on newly cleared forest land. In addition, two native plants, the Chinese Scrub (*Cassinia arcuata*) and the Nut Grass (*Cyperus rotundus*), have proved so troublesome as to be proclaimed for the whole State, while the native Prickly Acacia (*A. armata*) has been proclaimed for eleven shires, and the Three-cornered Jack (*Emex australis*) for two.

The sources of origin of the aliens show several points of interest. Naturally most are derived from plants with a wide general distribution. Thus 140 are native to Europe, Asia and Africa, and 66 to Europe and Asia. Of plants native to single continents, Europe has contributed 57 aliens, America 30, North America 18, South America 12, North and Central Africa 11, South Africa 29, and Asia 2. From the Mediterranean region 31 aliens are derived, whereas only 11 are native to Europe, Asia and America, 7 to Europe and Africa, 4 to Europe and America, and 2 to Asia and Africa. Only 8 of our aliens are general cosmopolitans exclusive of Australia, 13 are cosmopolitan to the temperate regions, 7 to the warmer zones, and 2 come from the N. Temperate and Arctic zones.

Not included in the above are the following single cases:—*Avelina Micheli* is derived from Italy, *Calycotome spinosa* from Spain, *Centaurea Picris* from the Caspian region, *Chloris abys-*

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sinica from Abyssinia, *Leycesteria formosa* from the Himalayas, *Lychnis divaricata* from Sicily, *Lycium chinense* from China, *Rubus phoenicolasius* from Japan, and *Verbena venosa* from the Argentine. Only one alien, *Eleusine coracana,* has its home in Asia, Africa and America, but several are native to other parts of Australia. *Albizzia lophantha* is native to West Australia and *Andropogon erianthoides* to New South Wales and Queensland, but both have become naturalised in Victoria. *Hibiscus Trionum,* which is native to Europe, Africa, Asia and Australia (with the exception of Victoria and Tasmania), has reached Victoria as an alien with the advent of civilisation, and in the same way *Setaria macrostachya,* which is native to Asia and Tropical Australia, has established itself in the South, aided by man. The activities of man, particularly through the transport of fodder, are probably responsible for the relatively high proportion of aliens contributed by South Africa, and these include some of our worst weeds both here and still more in West Australia (Cape weed, Onion grass, Stinking Roger, etc.).

The native flora of Victoria, exposed as it is to the competition of imported aliens and to the pressure of settlement, is in a condition of rapid flux. It is probable that less than half of the original flora will survive within 50 years, and that many plants originally widely spread will be confined to special localities. Were it not for the disturbing factors introduced by man the spread of the introduced aliens might have been used as a test of Willis's age and area hypothesis. As it is, although in a very general way the older weeds are more widely spread than the more recent introductions, the rule does not apply to hardly any comparable pair of individual cases. Thus the Evening Primrose, *Oenothera biennis* (1887), has covered less ground than the Foxglove, *Digitalis purpurea* (1917). The Musk Weed, *Myagrum perfoliatum* (1916) has become more abundant than the Horehound, *Marrubium vulgare* (1870), and Onion grass, *Romulea Bulbocodium* (recorded in 1873, but abundant in Melbourne in 1860), with twenty years' start has hardly covered more ground than St. John's Wort, *Hypericum perforatum* (recorded in 1893), but introduced in 1880. A still more striking case is that of the Stinkwort, *Inula graveolens* (1893), which rapidly overtook the Stinkweed, *Gilia squarrosa* (1887), both in area and in abundance.

One would expect the largest number of the naturalised aliens to belong to the Compositae (70), and the disproportionately high number derived from the Leguminosae (50), and from the Gramineae (102) is an aftermath of the pastoral phase when the world was searched for fodder plants to improve our pastures. The native Gramineae comprise 125 species, and many of these are dying out, so that in the near future the grass flora will be mainly foreign. Another curious disproportion is shown among the Monocotyledons. There are 13 alien Irids and only four of the Liliaceae, while no Orchid or Amaryllid has become naturalized, and only one alien sedge has crept in among the 111 native species of the Cyperaceae. As the native Irideae are only 8 in number, this is the first native order in which the aliens have widely outnumbered the natives. Of the total of 461 naturalized aliens all but twelve belong to natural orders already represented in the flora. The new orders added are Aroidaceae (1), Cactaceae (2), Dipsacaceae (2), Fumariaceae (1), Polemoniaceae (1), Pontederiaceae (1), Resedaceae (2), Salicaceae (1), Valerianaceae (1), but no member of the Myrtaceae, Sapindaceae or Rhamnaceae has become naturalized. Aliens are relatively high in the Labiatae, Solanaceae and Scrophulariaceae, nearly half the latter order being now represented in Victoria by naturalized aliens (24 native species to 18 aliens).

Strictly speaking, the age and area hypothesis is held to apply to closely related plants or to species of the same genus, although if true at all there seems no reason why it should not apply generally or why, if it does not apply generally, it should be true in a restricted form. Even taking species of the same genus, it appears that the time factor is of far less importance in determining the area covered by a species than its suitability to new habitats, its means of distribution, its aggressiveness and its resistance to foes and injurious agencies. In the case of the genus *Poa, P. annua, P. pratensis* and *P. trivialis* were recorded as naturalized in 1878, 1888 and 1888 respectively, but *P. pratensis* has taken the lead because it is better suited generally to the local conditions, and *P. compressa* (1908) is rapidly overtaking some of the earlier introductions. Similarly, in the case of the clovers, taking those which spread by natural means, *Trifolium glomeratum* (1892), is more widely spread than *T. arvense* (1887), and of the red (*T. pratense*), yellow (*T. procumbens*), and white clovers (all 1864), white clover (*T. repens*) has taken the lead mainly because of its superior means of natural distribution and its greater staying power.

According to Willis, however, comparisons cannot be made between single pairs of species, but only between groups of not less than 10 closely related species. As a matter of fact, if the age and area hypothesis has any general value, any average of any 10 pairs selected at random should be as good as two groups of ten each of related species. Even using 10 pairs of related species it is easy to construct natural cases in which the "law" could not apply. Thus, suppose a genus of five species is diverging through subgenera B, C and D, each of five species, and that in groups B and C, the size of the seed diminishes, and in group D that of the pappus, so that groups B and C have twice the rate of dispersal of A and D.

Then, taking any descending order of age for the species groups B and C will occupy double the area relatively to a given age as compared to groups A and D. Beneath the areas are set out proportionately to the ages and rate of spread in each group.

The ages selected are immaterial if they are set out in descending order.

Genus A.	Age in years.	Area in 10,000 acres.	Sub-Genus C.	Age in years.	Area in 10,000 acres.
1	6,000	60	1	2,500	50
2	5,500	55	2	2,000	40
3	5,500	55	3	2,000	40
4	4,500	45	4	1,500	30
5	4,500	45	5	1,000	20
Sub-Genus B.			Sub-Genus D.		
1	3,500	70	1	800	8
2	3,000	60	2	600	6
3	3,000	60	3	600	6
4	2,500	50	4	500	5
5	2,000	40	5	500	5
	Proportion total age to total area	1 : 135		1 : 175	

Hence the proportion between age and area may vary widely even in comparisons between groups of ten, each containing equal numbers of plants with the same rate of dispersal. If groups A and C are compared with groups B and D, the relative proportions between age and area are as 1 : 126 and as 1 : 61.

If groups B, C and D had all twice the rate of dispersal of A, then a simple arithmetical calculation shows that in 6000 years the area of group C and D would become equal to that of group A and B, whereas the average group ages would be as 57 : 100. Suppose that the dispersal of a plant is uniform, so that it spreads at the rate of a mile a year; then the area covered is proportional to the square of the distance of linear dispersal, i.e., to the square of the time, so that in one, two and three years the areas are respectively one, four and nine.

Hence if the groups A, B, C and D all had the same rate of spread and their average ages were 10,000, 5,000, 2,500, and 1,000 years, then the areas covered would be proportional to the squares of the ages, i.e., as (A) 100 : (B) 25 : (C) 9 : (D) 1. Thus the accidental inclusion of a single A plant in a D series because of an apparent close affinity would vitiate subsequent calculations, and to avoid such inclusions it is necessary to assume the age and area hypothesis, i.e., the very thing set out to be proved. It seems probable that the age of a species is one of the least important of the factors governing its distribution, and that in only few cases can a relation be traced between the age of species and the area they cover at the present day. The area of a cosmopolitan is limited by that of the surface of the earth, and during its existence a species like the common bracken or any other cosmopolitan may have travelled several times round the earth. Bracken certainly, and other cosmopolitans probably also, have had sufficient time to cover the surface of a planet far larger than Jupiter, and in such cases the present area of distribution cannot bear any definite relation to the age of the species.